AE2S
Think Big. Go Beyond.

Technical Memorandum

To: Jeff Deville – Watertown Municipal Utilities

From: Steve Burian, PE Steve L Burian, P.E.

Richard Wagner, PE Richard A. Wagner P.E.

Re: **Analysis of Sioux Rural Water Capacity to Serve West Side and East Side**

Date: August 12, 2016

Introduction

Advanced Engineering and Environmental Services, Inc. (AE2S) has been retained by Watertown Municipal Utilities (WMU) as an expert consultant to review the Watertown Service Area Report (WSAR), prepared by DGR Engineering for the Sioux Rural Water (SRW) System dated February 2016. This technical memorandum (TM) is a summary of the AE2S review and includes an evaluation of the SRW System capacity to serve areas to the east and west of the City of Watertown.

References

AE2S was provided a copy of the WSAR from WMU. The WSAR includes a five page overview of the SRW system, including background information, the Watertown service area, and a summary of the Sioux Water Treatment Plant (WTP). In addition, the WSAR includes a resume for Darin Schriever, PE in Appendix A, a preliminary engineering report for the Sioux Rural Water System in Appendix B, a preliminary engineering report addendum in Appendix C, proposed distribution improvements in Appendix D, and hydraulic modeling results in Appendix E.

Additional information was also provided by WMU, including historical water usage, building water service pipe size, and date of connection to WMU for specific users. This information is shown within this TM. WMU also provided information on the current city limits of Watertown which is labeled as Attachment No. 1. Attachment No. 2 and Attachment No. 3 are enlarged maps showing the West Side and the East Side, respectively, which reference the same areas as

the WSAR. Finally, the location of the individual users that are listed in Appendix E of the WSAR are shown on Attachment No. 4 and Attachment No. 5 which correspond to the West Side and East Side, respectively.

SRW System Overview

The SRW System reportedly serves approximately 1,435 users with two WTPs. One of the two WTPs is located near Castlewood, SD referred to as the Castlewood WTP, and the second is located 8.5 miles north of Castlewood, SD referred to as the Sioux WTP. The WSAR provides historical data on water demands with data from 2012 being the highest. The 2014 data was reported to have been higher, but this data was not available within the WSAR. The SRW System demand information for the area served by the Sioux WTP is summarized in Table 1 – SRW System Demand Summary and shows the average and peak day demands based on varying factors and in different units. Further discussion on these capacities is included within this TM, but for this initial evaluation of the capacity of system components a flow rate of 750 gallons per minute (gpm) will be used for the Castlewood WTP and flow rates of 400 gpm and 455 gpm will be used for the Sioux WTP. These two values, 400 gpm and 455 gpm, represent typical Sioux WTP operations per the WSAR and the peak day demand, respectively. In addition, Recommended Standards for Water Works (10 States Standards) indicates that water sources and treatment facilities shall be designed for maximum day demand at the design year. In this case, the 600,000 gallons per day peak day demand was considered as the benchmark to gauge system capacities.

Table 1 – SRW System Demand Summary

SRW System Event	Demand	Units	Source
Average Day	350,000	gallons/day	Per WSAR
Peak Day	600,000	gallons/day	Approximation, per Figure 4 WSAR
Peak Day (24 hour day)	417	gpm	Approximation, per Figure 4 WSAR
Peak Day (22 hour day)	455	gpm	Approximation, per Figure 4 WSAR; per 10 States Standards, capacity shall be designed for maximum day demand.
Peak Day (3-day Rolling Average)	550,000	gallons/day	Approximation, per Figure 4 WSAR

Capacity Of SRW System Components

The SRW System is generally comprised of water supply wells, raw water transmission, water treatment, and distribution which includes reservoirs, pump stations, pipelines, water towers, etc. AE2S reviewed the information provided within the WSAR from a technical capacity standpoint and has summarized the findings in the following sections. It should also be noted that AE2S did

not have access to additional information regarding the SRW System so is only relying on the information within the WSAR. As such, it was assumed that SRW System pipes, pump stations, equipment, and appurtenances have been properly maintained and are in proper working order.

Water Supply Capacity

The water source for the SRW System consists of a series of wells located west of Castlewood, SD within the Big Sioux Aquifer. The well field consists of six ground water wells that reportedly have a total combined capacity of 1,830 gallons per minute (gpm). Firm capacity, which is defined as the total combined capacity with the largest well out of service, is approximately 1,385 gpm. This firm capacity is sufficient to feed the two WTPs, which reportedly have a combined design capacity of 1,150 gpm (750 gpm and 400 gpm). Historical peak day demand from 2012 was also mentioned within Appendix B of the WSAR as being 1,400 gpm with 900 gpm dedicated to the Castlewood WTP and 500 gpm dedicated to the Sioux WTP. This combined flow rate exceeds the firm capacity of the well field and also exceeds the treatment capacity of the Sioux WTP discussed in subsequent sections.

Raw Water Transmission Capacity

The SRW System raw water wells are located adjacent to the Castlewood WTP. No information was provided on the raw water transmission pipelines between the well field and the Castlewood WTP. The raw water transmission pipeline between the aquifer and the Sioux WTP is listed as a 10-inch diameter pipe, approximately 8.5 miles in length. The pipe material and condition were not noted within the WSAR, but are assumed to be appropriate and in adequate condition. Per Advanced Water Distribution Modeling and Management (2003), transmission pipelines are typically sized to limit velocity to less than 3 feet per second (ft/sec) to limit head loss through the pipe. At a flow rate of 400 gpm or 455 gpm to the Sioux WTP, the flows through a nominal 10-inch pipe result in a velocity of approximately 1.6 ft/sec and 1.9 ft/sec, respectively. Both velocities are below the recommended maximum transmission pipeline velocity of 3 ft/sec. A 10-inch pipeline flowing at 3 ft/sec would convey a flow of approximately 750 gpm.

Water Treatment Capacity

The SRW System operates two WTPs per the WSAR and as noted previously, the Castlewood WTP and the Sioux WTP. Both WTPs are iron and manganese removal plants, both constructed in 1991, and have similar treatment processes. The processes of both WTPs consist of aeration, detention, and filtration. The Sioux WTP is the focus of this evaluation as this WTP treats and provides water to the northern portion of the SRW System which includes the East Side and West Side areas around the City of Watertown. Refer to Attachment No. 1 for the approximate location of these areas.

Per the WSAR, the Sioux WTP is indicated to have a range of flow capacities, generally referred to as the hydraulic capacity and the treatment capacity. The hydraulic capacity is the flow rate of water that can flow through the WTP without overflowing any process within the WTP. The treatment capacity is the flow rate that can flow through the WTP while achieving the finished water quality objectives. The hydraulic capacity and treatment capacity of the Sioux WTP are listed in the WSAR to be 600 gpm and 400 gpm, respectively. The hydraulic capacity is likely the original design flow rate of the WTP which was used to size the pipes, equipment, and appurtenances. The resulting treatment capacity is the flow through the WTP based on the most limiting component of the WTP. In this case, it appears the limiting factor is the finished water quality, specifically manganese which is referenced in the WSAR overview. A flow rate of 450 gpm was mentioned as the flow rate in which an increase in manganese levels in the finished water begins to become an issue, typically black water problems. The concentration of the manganese levels at this flow rate is not indicated, but is assumed to be greater than the SRW System treatment objectives. It should be noted that manganese is a secondary water quality parameter which is a guideline for water quality objectives and is not an enforceable primary drinking water standard. Parameters, like manganese, are referred to as secondary maximum contaminant levels (SMCL) and generally relate to aesthetics such as taste, color, and odor, which do not pose a health risk.

As the raw water from the wells enters the WTP, the first water treatment process is a single aerator. This aerator is indicated to be a 5-foot by 5-foot induced draft aerator with a capacity of 750 gpm, or 30 gpm per square foot (gpm/ft^2). Per 10 States Standards, the recommended loading rate for an induced draft aerator is 1 to 5 gpm/ft^2 of total tray area. It is unknown how many trays are present in the aerator, but assuming 10 States Standards are followed, a minimum of six trays would be necessary to reduce the 30 gpm/ft^2 loading rate to 5 gpm/ft^2.

The Sioux WTP is also listed to include two detention basins following the aerator with capacities of 13,300 gallons and 20,700 gallons, for a combined capacity of 34,000 gallons. The specific dimensions and configuration of these two basins are not provided, and it is not noted if baffles are located within these basins. For the purpose of this TM, it is assumed that the detention basins are baffled, which would promote adequate circulation of the water within the basin to allow for oxidation of the iron and manganese. The AWWA Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water System using Surface Water Sources provides a basis for evaluating the effectiveness of baffling and assigns a baffling coefficient to how well the basin is baffled. It is assumed that these basins have an average baffle system and thus are assigned a 0.5 baffling coefficient. Based on the 34,000 gallon capacity, 400 gpm flow rate, and a 0.5 baffling coefficient, the effective detention basin capacity is 43 minutes compared to 30 minutes as recommended by 10 States Standards. Higher flow through the WTP would lower the detention time, but assuming a baffle coefficient of 0.5, a total basin volume of 34,000 gallon, and 30 minute detention time per 10 State Standards, the WTP detention basins have a flow capacity of 567 gpm.

Following the detention basins are two gravity filters. Each filter is 10 feet by 10 feet in size, resulting in a combined filtration area of 200 square feet (ft^2). No information was provided on specific filter equipment or media material. Per 10 States Standards, the typical filtration rate for rapid rate gravity filters is 2 to 4 gpm/ft^2 with approval by the governing authority. For effective manganese removal, the lower end of this range is typically advisable. The WSAR indicates that the WTP filters can treat 400 gpm while achieving their finished water quality objectives, which results in a loading rate of 2 gpm/ft^2. The WSAR also indicates that a flow rate of 450 gpm (2.25 gpm/ft^2) results in an increase in manganese levels in the finished water.

10 States Standards indicates that when only two filters are provided, each filter shall be sized to meet the WTP design flowrate, which is typically the maximum day demand, at the specified filter loading rate. Based on this criteria, the Sioux WTP capacity would be dictated by the capacity of a single 10 ft by 10 ft filter (100 ft^2). Loading rates of 2 gpm/ft^2 to 2.25 gpm/ft^2 would result in a filtration capacity range of 200 gpm to 225 gpm based on the 10 States Standards guidelines.

Finished Water Storage Capacity

The SRW System has 13 finished water storage tanks located throughout the service area per Table 6 of the WSAR. Four of these storage tanks are located within the Sioux WTP distribution area and have a combined capacity of 468,000 gallons. Per 10 States Standards, the minimum storage capacity for systems not providing fire protection flows should be equal to the average daily demand. The average daily demand for the Sioux WTP service area is reported to be approximately 350,000 gallons which is less than the available storage of 468,000. Thus, sufficient storage appears to currently be in place as long as fire protection is not necessary.

Finished Water Distribution Capacity

The Sioux WTP treats and supplies water to the north and northeast portions of the rural water system including the East Side and West Side areas around the City of Watertown, SD. DGR Engineering utilized a computer hydraulic model, KY Pipe, to predict distribution system flows and pressures for this portion of the SRW System. The modeling results of this effort are included in Appendix E of the WSAR. Interpretation of the hydraulic model results are fairly limited herein due to minimal information available on the parameters used within the model. The following section discusses general items that may need to be considered or be investigated further to determine the true capacity and adequacy of the distribution system. Furthermore, the hydraulic model section discusses the distribution system pressures and flows based on specific system scenarios.

The SRW System also has multiple pump stations throughout its distribution system which are utilized to transfer water from the Sioux WTP to subsequent pumps stations, reservoirs, or users. Minimal information was provided on the details or capacity of this infrastructure, but it was noted in the WSAR that it has become difficult to convey water to the north near the City of

Watertown. Based on the write-up in Appendix B of the WSAR, various pump improvement scenarios have been conceptualized to address the water conveyance challenges.

Water Demand and Supply

The WSAR provides historical water usage for the Sioux WTP on Figure 4 of Appendix A. This figure indicates that during the months of March and July of 2012, daily water demand approached or exceeded 600,000 gallons per day. The three day moving averages for these periods are approximately 550,000 gallon per day for this period. These values were obtained from the graph on Figure 4, which result in an approximate values. The WSAR overview also indicates that more recent data from the spring of 2014 was used within the hydraulic model as this water demand was higher than in 2012. The 2014 values were not provided within the WSAR. Thus, the 2012 data was used for this TM.

Based on the WTP treatment capacity discussion above, the actual water production can vary depending on the available run times each day and the flow rate through the WTP, which also dictates the finished water quality. Based on the information provided in the WSAR, a 400 gpm flow rate produces water that meets their finished water quality objectives. Increasing this flow rate to 450 gpm, results in manganese breakthrough in the filters. Table 2 – Sioux WTP Capacity Ranges shows the various water production volumes based on these two flow rate variables and operation durations of 20, 22, and 24 hours.

Table 2 – Sioux WTP Capacity Ranges

Flow Rate (gpm)	Hours of Operation per Day (hours)	Water Produced Daily (gallons)
400	20	480,000
400	22	528,000
400	24	576,000
450	20	540,000
450	22	594,000
450	24	648,000

Using the 2012 peak day demands (2014 data is not available) of >600,000 gallons and the 2012 three day average of 550,000 and comparing these thresholds to Table 1, the Sioux WTP would need to operate at 400 gpm close to 24 hours a day for three days straight to keep up with demand, with storage depletion required to meet the peak day. This operational strategy leaves minimal time for backwashing and no maintenance. Operating the WTP at 450 gpm would require operating both filters about 22 hours per day with some storage depletion which does allow a few hours for backwashing but also reportedly produces water that has elevated manganese, which is aesthetically objectionable.

Hydraulic Model

The hydraulic model was setup and run by DGR Engineering based on a number of inputs that were described in the WSAR. One item that was initially questioned by AE2S during this review was the actual water usage and how quickly the water was needed by the various users. The average historic system wide water usage is reported to be approximately 4,700 gallons per connection per month (g/c/m). The hydraulic model, however, was reportedly run with an average monthly usage of 5,500 g/c/m to provide a factor of safety. The water demand diversity curve used for this modeling effort was not noted, but is assumed to vary depending on the number of users on each pipeline branch. The water demand diversity curve typically provides a decreasing water consumption factor as the number of users increase. This diversity curve allows long pipeline branches with many users to be modeled with a lower water consumption factor per user, but as the pipeline branch shortens and fewer users are present on the pipeline, a higher water consumption factor is utilized. This method allows rural water system pipes to be reasonably sized to meet minimum pressures during high demand periods but also reduces the potential for over-sized pipes. The results of the SRW System hydraulic model are included in Appendix E of the WSAR. The 5,500 g/c/m is likely adequate for a portion of the domestic users identified in Appendix E of the WSAR, but commercial users may need to be modeled with a greater water demand to reflect their actual usage and other hydraulic requirements.

Map 1 of Appendix E shows the location of the West Side area which is circled with a yellow highlighter. This circled area includes approximately 29 nodes on the existing rural water system pipeline showing the resulting water pressure under assumed peak demand with no improvements completed. Of these 29 nodes, only 8 of the nodes show a pressure being greater than 20 pounds per square inch (psi) which is the minimum allowable distribution pressure per 10 States Standards. The remaining 21 nodes are less than 20 psi with 6 of these nodes being less than zero psi. Based on these modeling results, it appears that there is inadequate distribution capacity to add additional users to the West Side without distribution system improvements. There may be potential to add a few users in locations of adequate pressure, but this will likely result in a decrease of pressure for other users downstream.

Map 10 of Appendix E shows the location of the East Side area which is also circled with a yellow highlighter. The 13 East Side users identified in Appendix E are located within this circled area although multiple other users, currently served by WMU, are also within this area, but have not been considered within the WSAR. This circled East Side area includes approximately 8 nodes on the existing rural water system pipeline. These 8 nodes range in pressure from 74 psi to 135 psi, well above the 20 psi recommended by 10 States Standards. Map 17 appears to be modeling the 13 additional users currently served by Watertown Municipal Utilites, along with pipeline improvements to reach these users. The modeling pressure results on Map 17 appear to be minimally impacted by these additional users although the impact to the existing system beyond this area is unknown. As stated in the WSAR, this area was modeled using a 5,500 g/c/m, while WMU has indicated that some of these 13 users have a higher water

consumption history than 5,500 g/c/m. Table 3 – Historical Annual Water Usage shows the total water use per year along with the average monthly water usage for each of these users.

Table 3 – Historical Annual Water Usage

East Side User	Annual Water Usage (gal)			Average Monthly Usage (gal)		
	2013	2014	2015	2013	2014	2015
Big Shot Fireworks	NA	NA	748	NA	NA	62*
Cross Country Couriers	NA	NA	15,708	NA	NA	1,309*
Dakota Automation	132,396	48,620	47,872	11,033	4,052	3,989
Fed Ex	32,164	25,432	29,920	2,680	2,119	2,493
Randy Hartley	59,840	60,588	54,604	4,987	5,049	4,550
Watertown Truck & Trailer	86,020	84,524	118,932	7,168	7,044	9,911
Lew's Fireworks	17,204	20,196	21,692	1,434	1,683	1,808
McFleegs	32,912	48,620	23,188	2,743	4,052	1,932
Rising Star	364,276	448,052	423,368	30,356	37,338	35,281
Jim Aesoph – Car Wash	NA	NA	748	NA	NA	62*
Jim Aesoph	8,976	10,472	7,480	748*	873*	623*
Wheelco	13,464	47,124	63,580	1,122	3,927	5,298
Wayne Weelborg	110,704	190,956	61,336	9,225	9,163	5,111

* Values may not reflect true monthly usage due to intermittent water use (i.e. seasonal variability)

As can be seen in Table 3, the 5,500 g/c/m average monthly assumption appears to initially be adequate for all of these users except two, Watertown Truck and Trailer and Rising Star. Recognizing that some of these users consist of unique businesses that have irregular water demand from one month to the next, however, further investigation into their water usage is necessary. Table 4 – Peak Monthly Water Usage was prepared to indicate the month each user used the most water and also show the magnitude of their usage. This table shows the month that had the highest water usage for years 2013, 2014, and 2015.

Table 4 – Peak Monthly Water Usage

East Side User	2013		2014		2015	
	Peak Month	Usage (gal)	Peak Month	Usage (gal)	Peak Month	Usage (gal)
Big Shot Fireworks	NA	NA	NA	NA	Dec	748
Cross Country Couriers	NA	NA	NA	NA	Aug	11,968
Dakota Automation	Aug	35,156	Aug	5,236	Multiple	4,488
Fed Ex	July	2,992	Multiple	2,992	June	5,236
Randy Hartley	April	5,984	Multiple	5,984	May	5,984
Watertown Truck & Trailer	Dec	31,416	Jan	14,212	Dec	12,716
Lew's Fireworks	July	4,488	July	3,740	July	4,488
McFleegs	June	17,952	April	11,220	May	6,732
Rising Star	Sept	71,808	Aug	92,752	July	90,508
Jim Aesoph – Car Wash	NA	NA	NA	NA	Oct	748
Jim Aesoph	NA	NA	Sept	2,244	Jan	1,496
Wheelco	Multiple	1,496	Mar	14,212	May	24,684
Wayne Weelborg	Jan	24,684	Sept	16,456	Feb	5,984

The breakdown shown in Table 4 indicates that seven of the 13 users had peak months that were in excess of the 5,500 g/c/m value used in the hydraulic model. This peak month usage was likely accounted for in the hydraulic model as a peak month usage of 15,850 g/c/m was approximated based on the WSAR data. Two users are still in excess of this peak monthly usage, but it is unclear how it may affect the overall SRW distribution system performance during peak usage periods. Further modeling with specific user water consumption data may be prudent to gauge the overall impact to the SRW System.

In review of the information provided by WMU, it was noted that these 13 users currently have water service pipeline sizes that range from 1-inch to 8-inch in diameter. Table 5 – Water Service Pipeline Size shows the line size for each of the East Side users. The SRW System is proposing to install a new pipeline to serve these users as shown on Map 13 of Appendix E of the WSAR. The diameter of this pipe is not noted, but SRW does have a 6-inch pipe in the general area of these East Side users. As shown in Table 5, one user, Fed Ex, has an 8-inch diameter service pipeline which is larger than the existing SRW pipe. Another user, Big Shot Fireworks, has a 6-inch diameter service pipe which would be equivalent in size to the existing SRW pipe. Additionaly, multiple other users have 4-inch and 2-inch service pipes, which are larger than the typical rural water customer and have the potential to be a high volume user. In consideration of the service pipe diameters, additional modeling for these users may be necessary as the large service pipes may be an indication of a need for high instantaneous water flows.

Table 5 – Water Service Pipeline Size

East Side User	Water Service Diameter	Date of Connection to WMU
	Inches	
Big Shot Fireworks	6	June, 2016
Cross Country Couriers	1	Dec, 2010
Dakota Automation	4	Sept, 2000
Fed Ex	8	Dec, 2012
Randy Hartley	4	Oct, 1992
Watertown Truck & Trailer	1	Oct, 2000
Lew's Fireworks	4	Nov, 2009
McFleegs	1	Nov, 2004
Rising Star	4	Nov, 1999
Jim Aesoph – Car Wash	2	Nov, 2014
Jim Aesoph	1	Feb, 2006
Wheelco	2	May, 2007
Wayne Weelborg	1	Nov, 2001

One potential reason for the larger water service pipes is the need for fire flow which is one potential high instantaneous water demand scenario. WMU indicated that Fed Ex and Big Shot Fireworks both have a sprinkler system within their buildings, although further investigation was not completed to determine the fire flows that these systems were designed for. In addition, fire flow requirements vary from one community to the next as these standards are typically addressed at the policy level within each community or by insurance providers. Insurance providers are specifically interested in fire flows as they provide a valuable public service by reducing loss of human life and property and also improve insurance ratings within the community.

Multiple methods are available to determine fire flow requirements, but the ISO method is the most common method used which describes the rate of flow considered necessary to control a major fire within a specific structure. This method was derived as a tool for use by the insurance industry in establishing fire insurance rates for individual properties based on the community's fire defenses. The results calculated using this method are generally consistent with alternative methods, although slightly higher due in part to the fact that the ISO method accounts for the need to protect adjacent buildings as well.

ISO utilizes the Fire Suppression Rating Schedule manual for reviewing the fire-fighting capabilities of individual communities. The schedule measures the major elements of a community's fire-suppression system and develops a numerical grading called a Public Protection Classification. ISO assigns a Public Protection Classification from 1 to 10. Class 1 represents the best protection, and Class 10 indicates no recognized protection. Ten percent of the overall grading is based on how well the fire department receives fire alarms and dispatches its fire-fighting resources. Fifty percent is based on the number of fire engine companies and the amount of water a community requires to fight a fire. ISO reviews the distribution of fire engine companies throughout the area and checks that the fire department tests its pumps regularly and inventories each fire engine company's nozzles, hoses, breathing apparatus, and other equipment. Forty percent of the grading is based on the community's water supply. This part of the survey focuses on whether the community has sufficient water supply for fire suppression beyond daily maximum consumption. To determine the rate of flow the water mains provide, ISO observes fire-flow tests at representative locations in the community. Depending on the location of a structure and zoning area and the predicted fire demand for that zone, the structure may be required to have a sprinkler system or means of providing additional fire flow to the structure either through water main or storage improvements.

As indicated above, fire flows may have a significant impact on business operations of the users and on their insurability. These fire flows will need to be determined and factored into the SRW model to determine SRW's capacity to serve the noted additional users.

Conclusion

WMU retained AE2S as an expert consultant to complete a technical evaluation of the capacity of a portion of the SRW System. Table 6 – SRW System Demand Summary is a summary of the reported water demands for the Sioux WTP, and Table 7 – SRW Capacity Summary indicates the current capacity of various SRW System components with comparison to the estimated required capacity.

Table 6 – SRW System Demand Summary

SRW System Event	Demand	Units	Source
Average Day	350,000	gallons/day	Per WSAR
Peak Day	600,000	gallons/day	Approximation, per Figure 4 WSAR
Peak Day (24 hour day)	417	gpm	Approximation, per Figure 4 WSAR
Peak Day (22 hour day)	455	gpm	Approximation, per Figure 4 WSAR; per 10 States Standards, capacity shall be designed for maximum day demand.
Peak Day (3-day Rolling Average)	550,000	gallons/day	Approximation, per Figure 4 WSAR

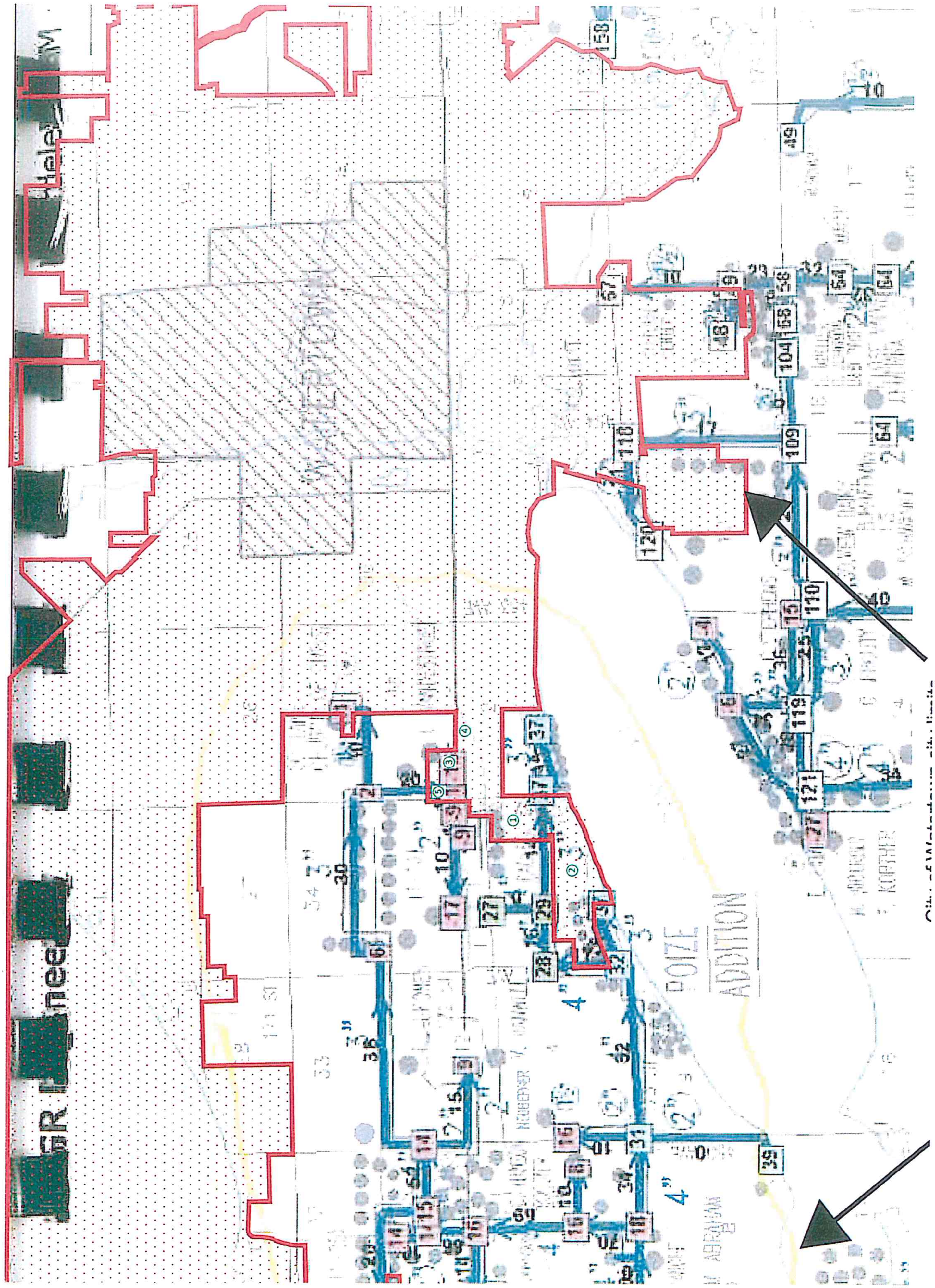
Table 7 – SRW Capacity Summary

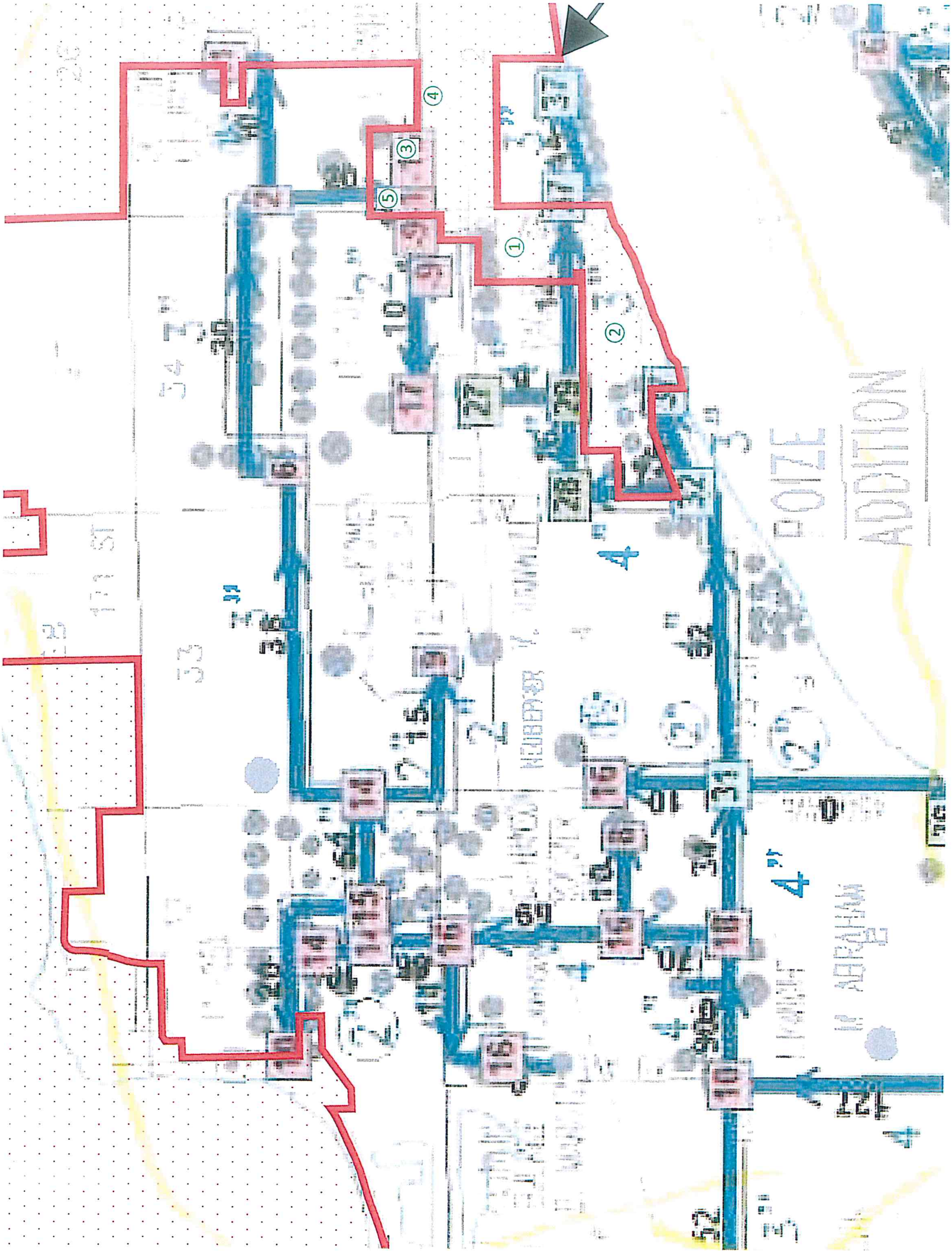
SRW System Component	Capacity	Units	Capacity Status
Water Supply			
Wells			
Total Capacity	1,830	gpm	Serves both WTPs
Firm Capacity	1,358	gpm	Capacity Appears Adequate; 455 gpm required at the Sioux WTP, 750 gpm reportedly required at the Castlewood WTP
Raw Water Transmission Pipeline (3 ft/s Velocity Assumed)	750	gpm	Capacity Appears Adequate; exceeds maximum day demand of 455 gpm per 10 States Standards
Sioux WTP			
Aerator	750	gpm	Capacity Appears Adequate; exceeds maximum day demand of 455 gpm per 10 States Standards, although lacks redundancy
Detention Basins (30 minutes with 0.5 baffle coefficient)	567	gpm	Capacity Appears Adequate; exceeds maximum day demand of 455 gpm per 10 States Standards
Filters (2 filters, 2 gpm/ft2 loading rate, manganese break through point)	400	gpm	Capacity Appears Deficient; unable to meet maximum day demand of 455 gpm per 10 States Standards; two filter design does not meet 10 States Standards
Capacity Ranges (20 to 24 hours per day of operation)			
400 gpm	480,000 to 576,000	gallons/day	Capacity Appears Deficient; unable to achieve maximum day demand of 600,000 per 10 States Standards
450 gpm	540,000 to 648,000	gallons/day	Capacity Appears Deficient; exceeds filter loading rate of 400 gpm (manganese breakthrough per WSAR, may lack sufficient backwash time)
Finished Water Storage	468,000	gallons	Capacity Appears Adequate; greater than average day demand per 10 States Standards

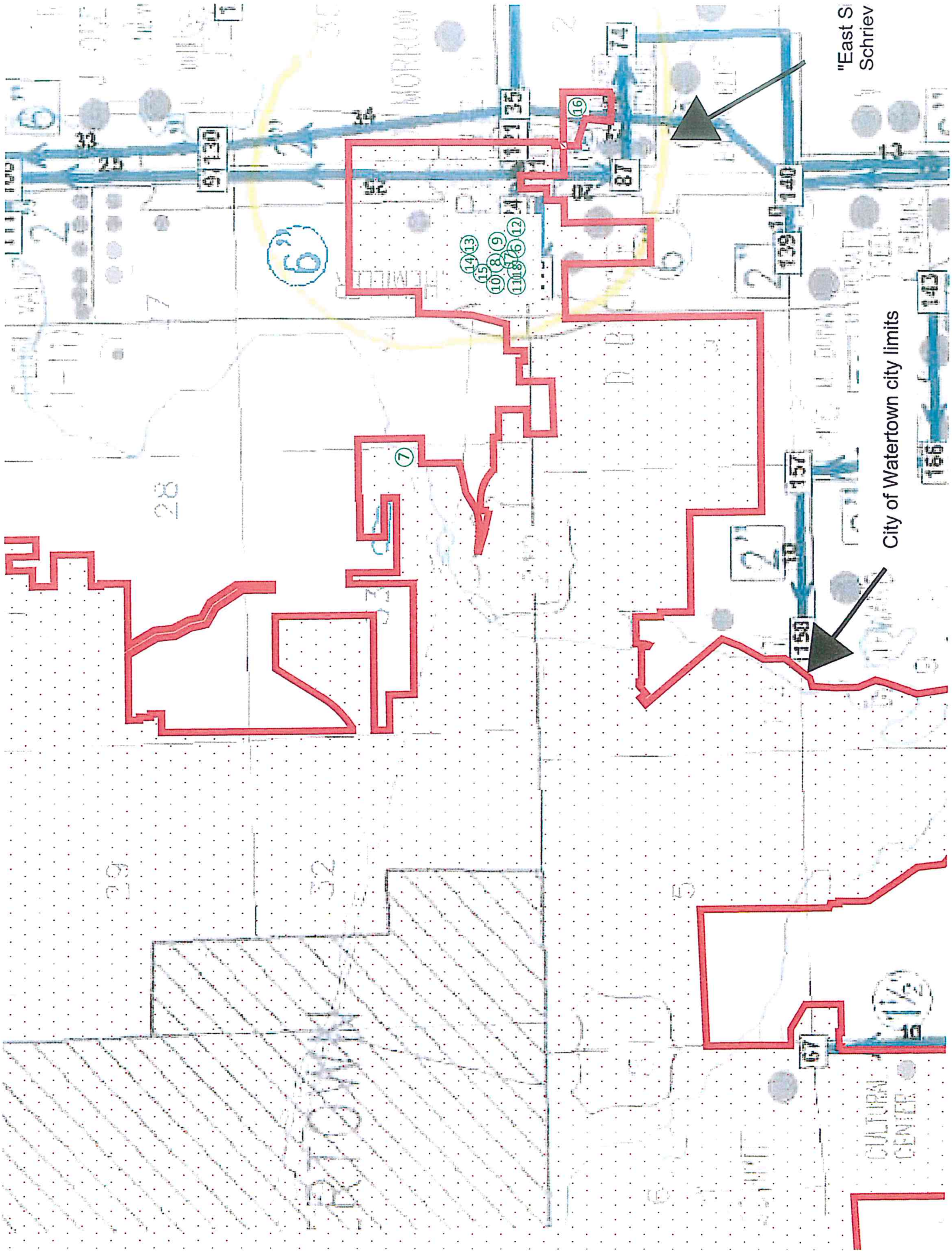
Table 7 – SRW Capacity Summary (continued)

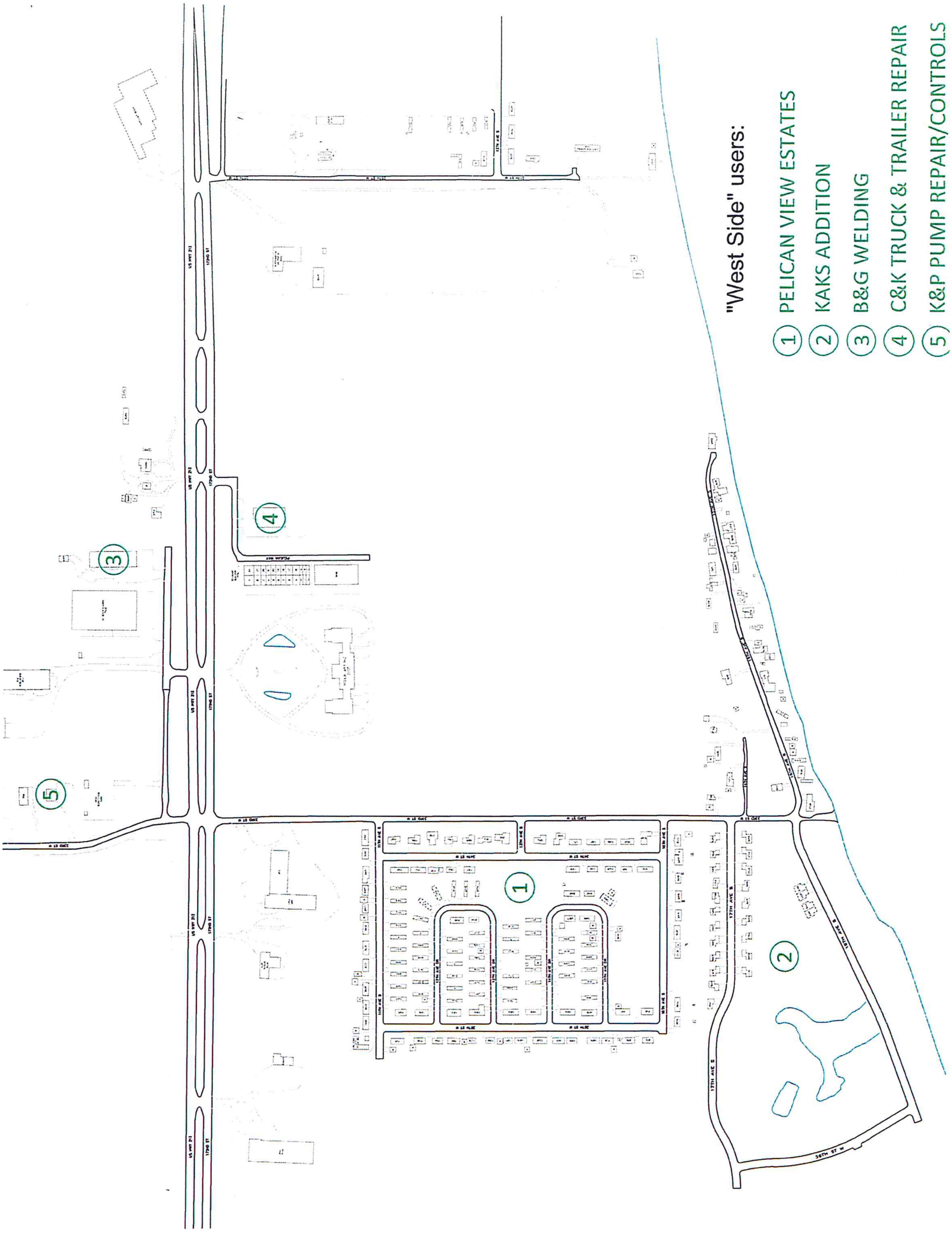
SRW System Component	Capacity	Units	Capacity Status
Water Distribution			
Domestic Demands			
West Side	5,500	g/c/m	Capacity Appears Deficient; existing users (without new users) experience pressures less than 10 States Standards 20 psi minimum pressure recommendation
East Side	5,500	g/c/m	Acceptability of Capacity is Unknown; unique water users are located within this area, further modeling is required at actual required flow rates
Fire Flow Demands			
West Side	?	gpm	Capacity Appears Deficient; existing system modeling results indicate pressures less than zero psi.
East Side	?	gpm	Acceptability of Capacity is Unknown; additional modeling is required to determine available fire flow; service lines approaching, matching, or exceeding the SRW distribution pipe size suggest likely challenges

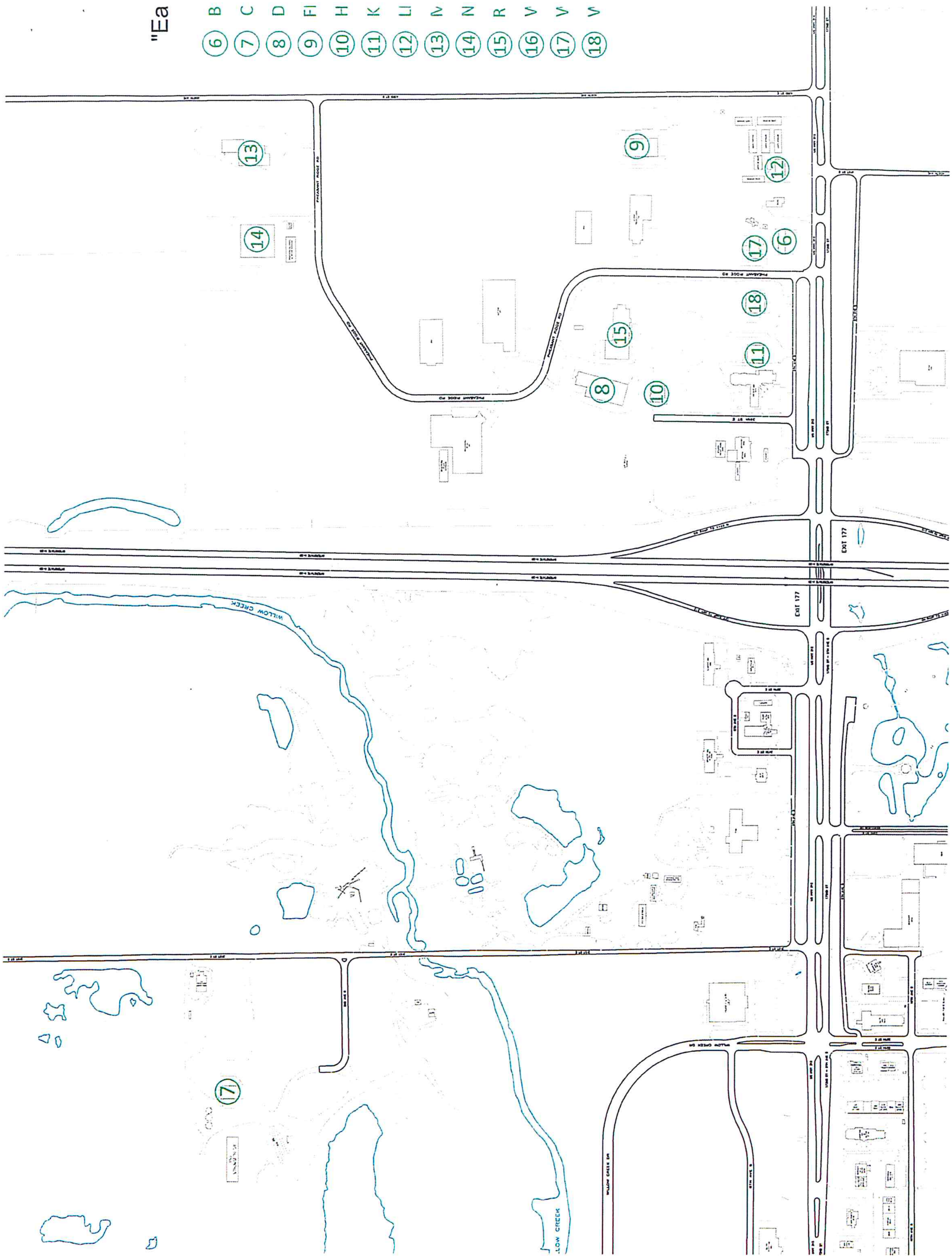
A water system is comprised of numerous components all working together to provide water to its customers. The total capacity of any system is equal to its most limiting component. As shown in Table 7 – SRW Capacity Summary, it appears that the most limiting component of the water supply system is the filtration capacity, which appears to be inadequate to meet peak day demands and is not designed to 10 States Standards. This limitation leaves the portion of the SRW System served by the Sioux WTP with no capacity for additional users. The limiting components of the water distribution system on the West Side appear to be inadequate pressure which affects both domestic flows and fire flows. These limitations also leave this portion of the SRW System with no capacity for additional users. The East Side may also be limited by domestic flows and fire flows. Based on existing data available in the WSAR and used by DGR Engineering and AE2S, additional modeling is necessary to provide an opinion regarding the adequacy of flows to serve additional customers on the East Side.


POIZE
ADDITION


POZE
ADDITION


"East S
Schriev
City of Watertown city limits
CULTURAL CENTER


"West Side" users:
1 PELICAN VIEW ESTATES
2 KAKS ADDITION
3 B&G WELDING
4 C&K TRUCK & TRAILER REPAIR
5 K&P PUMP REPAIR/CONTROLS


EXIT 177
WILLOW CREEK

Steve L. Burian, PE

Chief Executive Officer

EXPERIENCE

Mr. Burian is one of two founders of Advanced Engineering and Environmental Services, Inc. (AE2S). Founded in 1991, AE2S has focused on water from the beginning. With over 25 years of engineering experience, Steve is passionate about the advancement of water infrastructure in the Upper Midwest and ensuring safe quality water across the region.

Mr. Burian's project management and project engineering experience for water and wastewater systems includes coordination and completion of concept planning, master planning, facility planning, capital improvement planning, funding development, rate studies, regulatory interface, public presentation and interface, cultural/environmental resource compliance, water supply planning and permitting, wastewater discharge permitting, drinking water regulatory evaluation and research coordination, pilot and plant scale studies, process design, construction administration and observation, operations consultation, and program management.

Over the past 25 years, Mr. Burian has been the principal-in-charge for hundreds of water system projects for both rural water systems and municipalities. His experience includes both ground water and surface water, supply, treatment, pumping, distribution, and controls systems. Among these projects includes the largest regional water system being developed in North Dakota estimated to cost over $1 Billion, the Red River Valley Water Supply Project. In addition, Mr. Burian has been an integral part of developing the Western Area Water Supply Project, a regional water system in the western portion of North Dakota to supply water for the extreme population growth and associated development from the production of oil in the Bakken Shale Formation. His role included creation of a business plan, funding development, legislative support and testifying before State Legislators, various financial support services, and management of the design and construction of water treatment plant, storage, pumping, pipeline, and related infrastructure.

Mr. Burian has also historically served in various consulting roles for numerous adjacent rural water systems and municipalities working to address territorial service issues and optimize regionalization.

EDUCATION

Master of Engineering, Civil Engineering with Environmental Emphasis, University of North Dakota (1992)

Bachelor of Science, Civil Engineering, University of North Dakota (1990)

REGISTRATIONS

Professional Engineer: South Dakota, North Dakota, Minnesota, Montana, Wyoming

CONTACT

Steve.Burian@ae2s.com
T: 701-746-8087
C: 701-740-4881

Exhibit A

Richard Wagner, PE

Assistant Operations Manager

EXPERIENCE

Mr. Wagner's experience includes a variety of projects in the water field relating to municipal and rural systems. He has provided project management, planning, design, and construction administration on intakes, raw water pump stations, wells, water treatment facilities, high service pump stations, water transmission and distribution systems, and water storage reservoirs.

Mr. Wagner's experience in a variety of roles for over a hundred water system projects gives him a comprehensive understanding of water system infrastructure and operations. Over the past 15 years, Richard has worked on numerous rural water systems across the upper midwest. He has extensive experience in working with rural communities from planning and funding to start-up and operations.

Mr. Wagner has been the project manager for multiple rural water systems including the expansion of a large rural water system in southeast North Dakota. The major improvements project included the assessment of the existing water supply, treatment, and distribution system, possibilities for expansion of service to new users, development of solutions to quality and regulatory issues, expansion of the well field, construction of new raw water transmission pipeline, and design and construction of a new 2.3 MGD water treatment plant expansion at a total project cost of $21 Million.

EDUCATION

Bachelor of Science, Civil Engineering
University of North Dakota (2000)

REGISTRATIONS/CERTIFICATIONS

Professional Engineer: South Dakota, North Dakota, Minnesota, Iowa

CONTACT

Richard.Wagner@ae2s.com
Tel: 218-299-5610
Fax: 218-299-5611

AE2S
www.ae2s.com

August 12, 2016

Jack H. Hieb, Attorney at Law
Richardson, Wyly, Wise, Sauck & Hieb, LLP
One Court St
Aberdeen, SD 57402-1030

RE: **Analysis of Sioux Rural Water Capacity to Serve West Side and East Side Disclosures and Statement of Compensation**

Dear Mr. Hieb:

Steve L. Burian and Richard A. Wagner have not had any articles published in any professional publications in the past 10 years.

Steve L. Burian and Richard A. Wagner have not served as an expert witness either by deposition or at trial in the past 4 years.

Steve L. Burian and Richard A. Wagner are being compensated for their work on this project at their standard billing rates of $225 per hour and $179 per hour, respectively.

Should you have any questions or need additional information, please feel free to contact Steve at (701) 746-8087 or Richard at (218) 299-5610.

Sincerely,

AE2S

Steve L. Burian

Richard A. Wagner

Advanced Engineering and Environmental Services, Inc.
3101 South Frontage Road • Moorhead, MN 56560 • (t) 218-299-5610 • (f) 218-299-5611